International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 4, May-June 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Design and Analysis of Portable Dishwasher

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ABSTRACT

There is a need of commercial dishwashers in the big hotel chains, for the purpose of cleaning dishes efficiently and cheaply. All the models of commercial dishwashers today rely completely on water cycles for the purpose of cleaning dishes. The water usage is very high in them. Also, some of the models do not provide the desired clean whereas some are not suitable for particular type of dish material. And all of them use hot water which further increases the cost of heating the water to desired temperature.

Our aim is to provide a solution to these problems by the use of rolling mechanism, which would allow the brushing bristles to come in contact with dishes for cleaning rather than relying completely on water, which would provide a hand like clean. This would reduce the excessive use of water and provide more satisfactory clean with an experience of traditional hand cleaning.

Washing dishes is most commonly done activity in the world, in most of families' people wash dishes by hand which is straining to muscles and detergent is chemically harmful. As far as manual process is concerned in houses of India, washing is done by hand scrubbing which is straining to the muscles through its energy and postural requirements.

How to cite this paper: Sangharsh Gaikwad | Aman Chandrikapure | Roshan Daf | Janvi Meshram | Darpana Chowhan | Rajat Wankhede "Design and Analysis of Portable Dishwasher" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-4, June 2021, pp.1515-1521, URL: www.ijtsrd.com/papers/ijtsrd43610.pdf

IJTSRD43610

I. INTRODUCTION

Dishwashers can be used to cook foods at low temperatures. The foods are generally sealed in canning jars or oven bags since even a dishwasher cycle without soap can deposit residual soap and rinse aid from previous cycles on unsealed foods.

Dishwashers also have been documented to be used to clean potatoes, other root vegetables, garden tools, sneakers or trainers, silk flowers, some sporting goods, plastic hairbrushes, baseball caps, plastic toys, toothbrushes, flip-flops, contact lens cases, a mesh filter from a range hood, refrigerator shelves and bins, toothbrush holders, pet bowls and pet toys. Cleaning vegetables and plastics is controversial since vegetables can be contaminated by soap and rinse aid from previous cycles and the heat of most standard dishwashers can cause BPA or phthalates to leach out of plastic products. The use of a dishwasher to clean greasy tools and parts is not recommended as the grease can clog the dishwasher.

Fig.1.1 Dishwasher

FIELD OF THE INVENTION: -

The first dishwasher to be granted a patent was invented in 1850 by Joel Houghton. It was a wooden box that used a hand-turned wheel to splash water on dirty dishes, and it had scrubbers. The function of the dishwasher is to provide the mechanical action necessary to distribute and direct the detergent solution and rinse waters over, under and around the dishes to loosen and remove soil.

BACKGROUND OF THE INVENTION: -

Cochran invented the first practical dishwasher. She designed the first model in the shed behind her house in Shelbyville, Illinois. Her dishwasher was the first to use water pressure instead of scrubbers to clean the dishes. She received a patent on December 28, 1886. It was invented by Cochrane together with mechanic George Butters in Cochrane's tool shed in Shelbyville, Illinois when Cochrane (a wealthy socialite) wanted to protect her China while it was being washed. A motor powered the wheel, which turned as soapy water was squirted on the dishes to clean them. Cochran was granted a U.S. patent in 1886 for her machine, which she named the Cochran dishwasher. She advertised her invention in local newspapers and built the machines for friends and family. In the United Kingdom, William Howard Livens invented a small, non-electric dishwasher suitable for domestic use in 1924. It was the first dishwasher that incorporated most of the design elements that are featured in the models of today. It included a front door for loading, a wire rack to hold the dirty crockery and a rotating sprayer. Drying elements were even added to his design in 1940. It was the first machine suitable for domestic use and it came at a time when permanent plumbing and

running water in the house was becoming increasingly common.

Despite this, Livens design did not become a commercial success. Dishwashers were only successfully sold as domestic utilities in the post-war boom of the 1950s, albeit only to the wealthy. Initially, dishwashers were sold as standalone or portable devices, but with the development of the wall-to-wall countertop and standardized height cabinets, dishwashers began to be marketed with standardized sizes and shape integrated underneath the kitchen countertop as a modular unit with other kitchen appliances. By the 1970s, dishwashers had become commonplace in domestic residences in North America and Western Europe. By 2012, over 75% of homes in the United States and Germany had dishwashers. In the late 1990s, manufacturers began offering various new energy conservation features in dishwashers. One feature was the use of "soil sensors," a computerized tool in the dishwasher which measured food particles coming from dishes. When the dishwasher had cleaned the dishes to the point of not releasing more food particles, then the soil sensor would report the dishes being cleaned. The sensor operated with another innovation of using variable washing time.

electronic files or print, machining, or other manufacturing operations.

II. CAD Model

Computer Aided Design (CAD) is the use of computer system to assist in the creation, modification and analysis or optimization of design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create database for manufacturing. CAD output is often in the form of electronic files or print, machining, or other manufacturing operations. CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

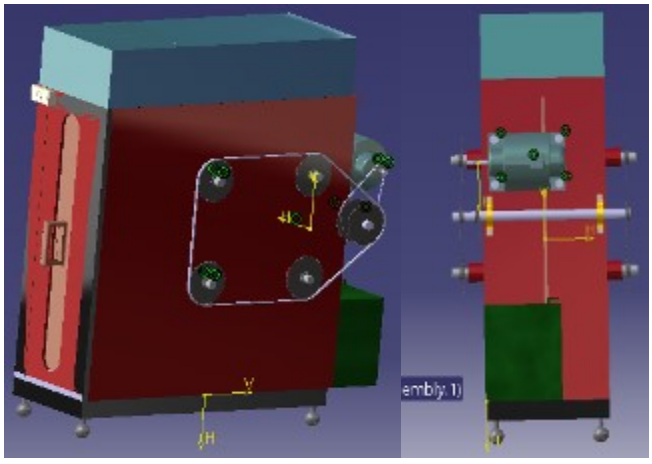
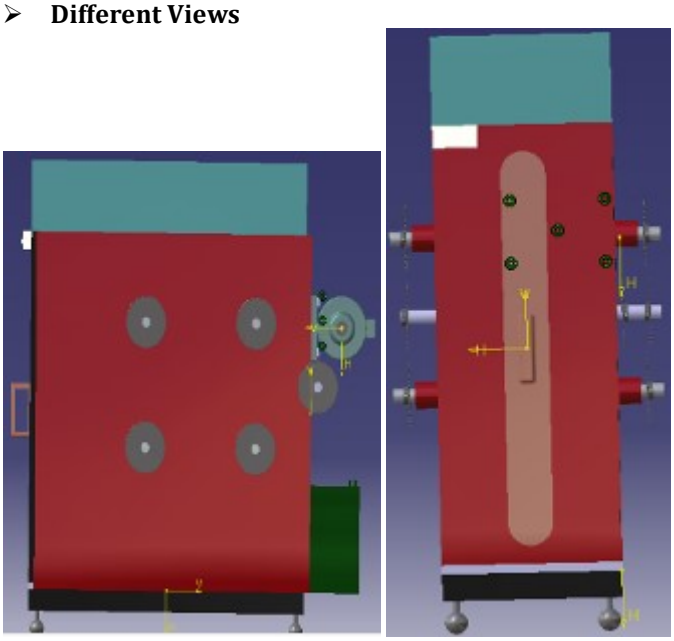
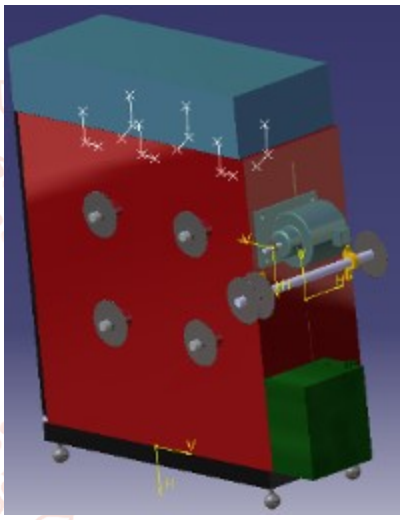


Fig 2.1 Conceptual Model

- **Different Views**



SIDE VIEW **FRONT VIEW**



ISOMETRIC VIEW

Fig 2.2 Different views of CAD Model

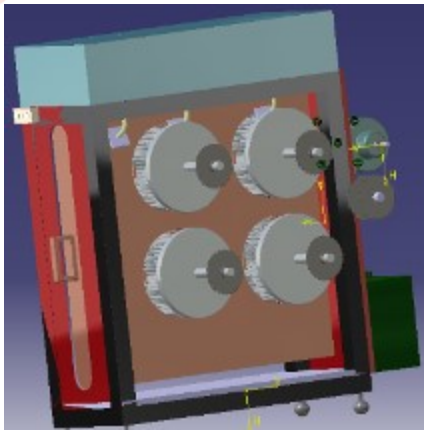


Fig 2.3 CAD Model

III. LIST OF COMPONENTS

SR. NO	COMPONENTS
1.	Casing
2.	Motor
3.	Sprocket
4.	Mop
5.	Chain
6	Bearing
7.	Dish Holder
8.	Shaft
9.	Frame
10.	Battery
11.	Wheels
12.	Pipe
13.	Shower
14.	Nut and Bolts

Table 3.1 Components

1. CASING

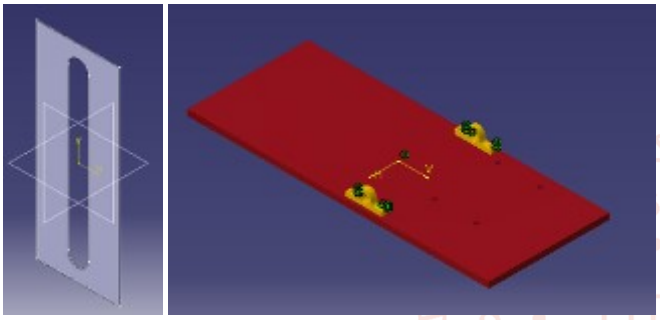


Fig: -3.1 Casing

Specifications: -
Number of casing =8
Material =CRCA Sheet

2. MOTOR

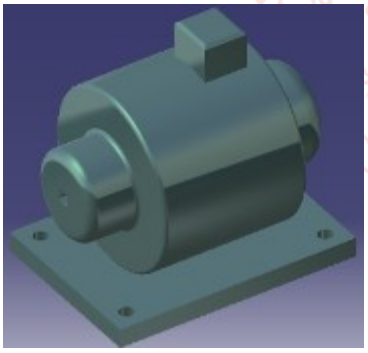


Fig: -3.2 Motor

Motor Specifications: -
1hp
1400 rpm
12V

3. Sprocket

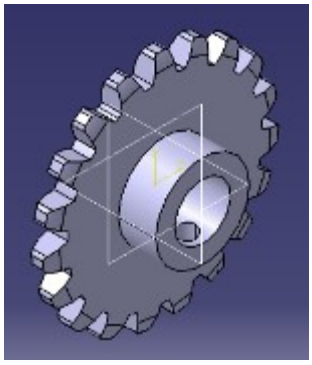


Fig: -3.3 Sprocket

Specifications: -
Number of Sprocket=12
Material=Steel Alloy
10 sprockets of diameter-10cm each
1 sprocket diameter-7cm
1 sprocket diameter -4.193cm

4. Mop

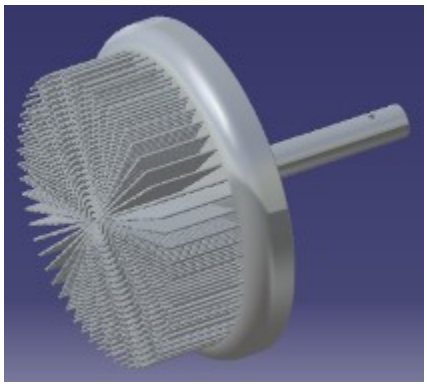


Fig: -3.4 Mop

Specifications: -
Number of Mop =8
Diameter of mop -30c,
Thickness of mop -4cm
Length of Bristles -7cm
Material of disc = Fibre 400
Material of threads = Nylon

5. Bearings

Fig: -5.5 Bearing

Specifications: -
Number of Bearings = 8
Material=Chrome steel SAE 52100
Diameter of bearing-3cm
Outer diameter of bearing -4cm

6. Dish Holder

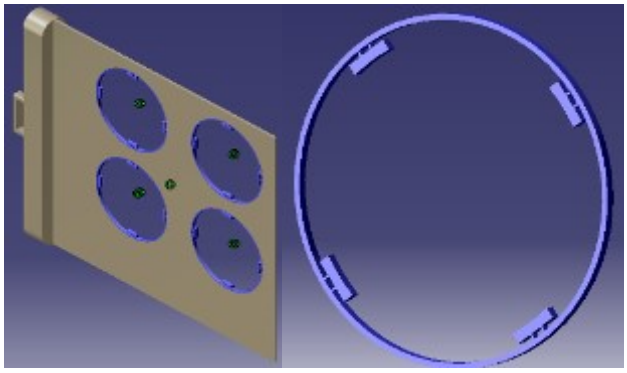


Fig: -5.6 Dish Holder

Specifications: -
Number of Dish Holders =4

Material=Steel
Diameter of dish holder -30cm

7. Shaft

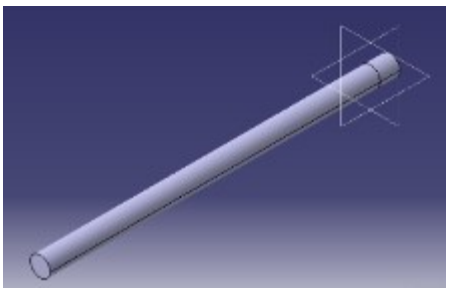


Fig: -5.7 Shaft

Specifications: -
Main shaft
Diameter-3cm
Material: -Mild steel

Mop Shaft
No of shaft-8
shaft diameter-3 cm

Motor Shaft
No of shaft -1
Shaft Diameter-1.5cm

8. Frame

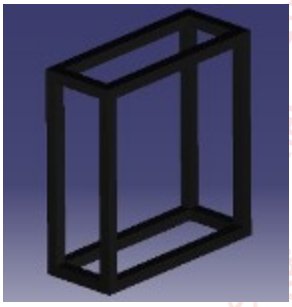


Fig: -5.8 Body Frame

Specifications: -
Number of Body Frame =1
Material=Mild Steel

9. Battery

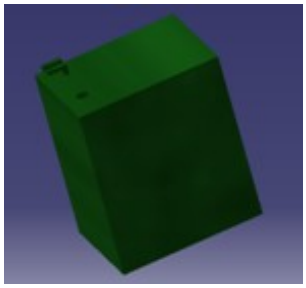


Fig: -5.9 Battery

Specifications: -
Number of Battery =1
12-volt 120 Ah

10. Wheels

Fig: -5.10 wheel

Specifications: -
Number of Wheels =4
Material=Cast Iron

11. Pipes

Fig 5.11: -The Pipe shown above is a Flexible Copper Pipe

Copper tubing is most often used for heating systems and as a refrigerant line in HVAC systems. Copper tubing is slowly being replaced by PEX tubing in hot and cold-water applications. There are two basic types of copper tubing, soft copper and rigid copper. Copper tubing is joined using flare connection, compression connection, pressed connection, or solder. Copper offers a high level of corrosion resistance but is becoming very costly.

12. Shower

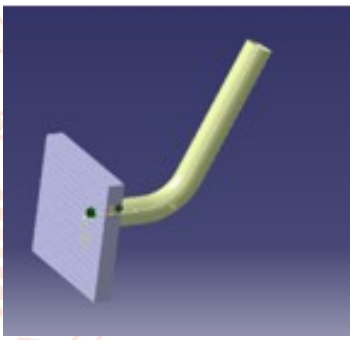


Fig: -5.12 Shower

Specifications: -
Number of Shower =4
Material=Acrylonitrile butadiene styrene

IV. CONSTRUCTION

- A Dishwasher have a frame of some dimensions in which we have assembled various components.
- We have a rotor of 1400 rpm where we attached a chain drive mechanism which is providing power to main shaft.
- The main shaft has two sprockets at each corner which are providing the power to both side of dishwasher.
- Further, the chain drive is assembled in pentagonal shape where at each corner there is sprocket connected to the shaft.
- The shaft is further connected to the mop.
- From the front there is opening for a tray which is connected through slider mechanism which helps them to and fro motion to the tray.
- The tray consists of four dish holders.
- We have container above the frame for the storage of soap water and clean water.
- From the container of water flow through the pipe to the shower.
- The shower is placed at top corner at such angle, the water reaches to all four dishes.
- At the bottom there is a drainage system for waste water and soil materials.

V. WORKING

- We have to place our four dishes into the dish-holder and lock it on.
- Then we introduce dish-holder tray into the dishwasher.
- We have motor of 1 HP which will power up the whole system and which will help rotate the mob at about 400rpm(ideal).
- As we have placed tray at the place and motor is ready.
- Then the working starts as the mob rubs against the dishes and water-soap solution from the top.
- Every mob is adjacent to a dish placed in the holder.
- After washing dishes, while removing the holding tray clean water is supply to clean the dishes of soap residue

CALCULATIONS

Rpm Calculations

Motor speed= N_1= 1400 rpm

desired speed of sprocket = N_2 =400 rpm

N1/N2 velocity ratio = 1400 /400 = 3.5 < 10.

also - we know that

N1/N2=Z2/Z1

Z2= no of teeth on driven

Z1=no of teeth on driver.

Now, as the motor is of 1 HP and Single Strand

From DDB (fig. 14.1)

Z1 is found out to be Z1 = 21

Corresponding pitch will be

P= 6.25 mm

from velocity ratio.

N1/ N_2=Z1/Z2 = 3·5

Z2 = 3.5 * Z1 = 3.5*21=73.5 ~73

From DDB Pg. no 150 & Tb. no. XIV-1

Design power (PD) = (PR)*K_1

PR = rated power = 1 HP = 1x 746 Watts

and K_1 = 1.2. for moderate Shock loading and service of 10 hours per day

from DDB. pg no 150 & Tb. no. XIV-2

PD = 746 x 1.2

PD = 895.2 Watts.

1. Design of sprocket Pinion. (Driver)

DP of sprocket= P/sin (180/Z1) =6.25/sin (180/21)= 41.934mm

width of sprocket = to = 0.58 (p)-015
= 0.58 (625) 0.15= 3.475 mm

corner relief. e=0125 *P = 0·125 X 6.25
= 0.78125 mm

Chamfer radius r = 0·54 P= 054 x 6.25
r= 3.875 mm

Outside diameter = Do = P(0.6+cot(180/T)
Do = 6.25 (0.6 + 1/tan (180/21))
Do= 45.216 mm

root diameter = Dr = Dp -0.625P

=41.932- (0.625x625)

Dr= 39.902 mm

2. Design of sprocket (driven)

Dp =p/sin (180/Z2) =6.25/ sin (180/73) =145.273mm

to= 0·58(p) - 0.15

to= 3.475 mm

e = 0·78125 mm

r= 3.375

Do= p(0.6 + cot (180/T):

=6.25(0.6 + cot (180/73)

Do = 148.889 mm

root dia = Dr =Dp -0.625P

= 145.273 - (0.625 x 6.25)

Dr= 141.366 mm

3. Design of chain.

Centre distance = C = Diameter of larger Sprocket + ½ diameter of smaller Sprocket= 145.273 +1/2(41.934)= 166.24 mm

Roller dia=dr = 5/8*p = 5/8* 6.25 = 3.906 mm

chain width=W = 5/8*p =5/8*6.25 = 3.906mm

pin dia= dp = 5 /16*p = 5/16x6.25 =1.953 mm

Thickness of link plate = 1/8*p = 6.255/8=0.7812mm

max ht of pin link plates. = Hp =0.82 * 6.25
=5.125

Max ht of roller link plate

Hp=0.95*6.25

Hp=5.937mm

- **Torque calculation.**

1. Torque provided by motor

P= 2πNT/60

T = P* 60/2π*N

=895.2 X 60/2π*1400

T= 6·1060 Nm

2. Torque provided by motor.

T= P*60/2πN

=895.2*60/2π*400

T=21.371 Nm

Chain length

Centre distance= x=166.24mm

x=m*p

m=x/p

=166.24/6.25=26.5984

L=p*K

Where, L= length of chain

p=pitch

K=Multiplying factor

K=(Z1+Z2)/2+2m+{[cosec(180/Z1)-cosec(180/Z2)] ^2 /4m}

= (21+73)/2+2(26.60) + {[cosec (180/21)-cosec (180/73)] ^2 /4*26.59}

=102.77

L=p*K

=102.77*6.25

=642.3125mm

VI. ANALYSIS

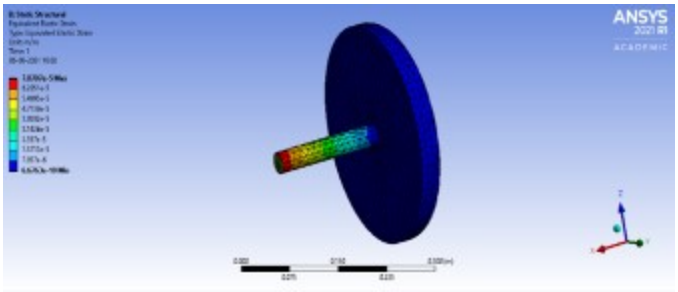


Fig6.1Strain produced at every point on the mop

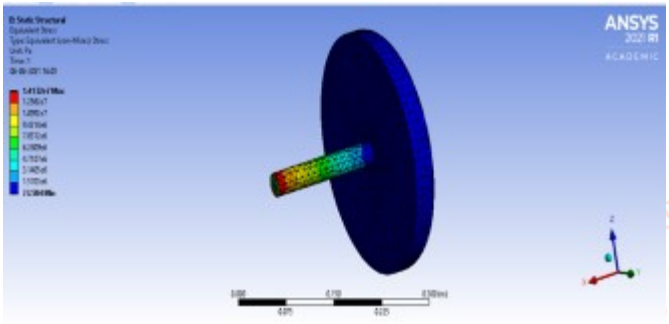


Fig6.2: -Stress developed at every point on the mop

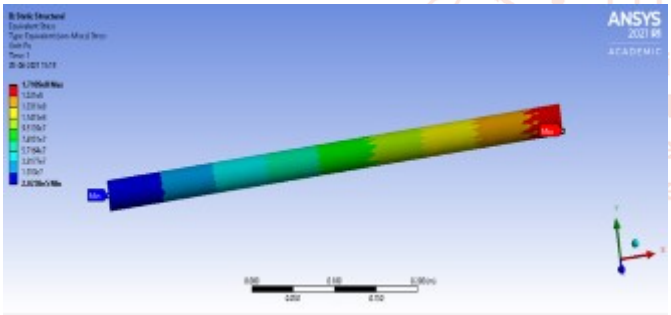


Fig6.3-Stress developed on every part of the shaft

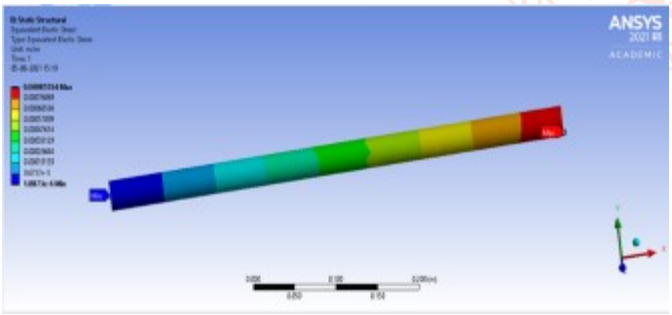


Fig6.4-Strain produced by each part of shaft

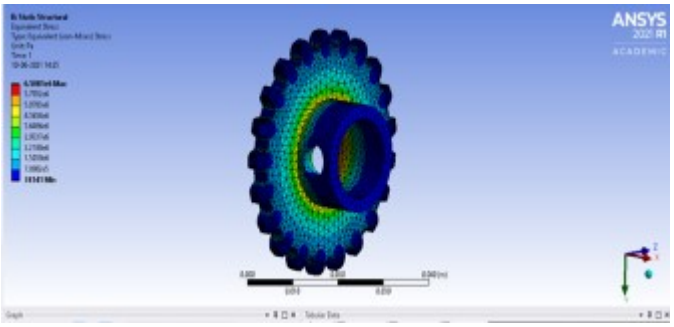


Fig6.5-Stress produced after Rotation of motor sprocket

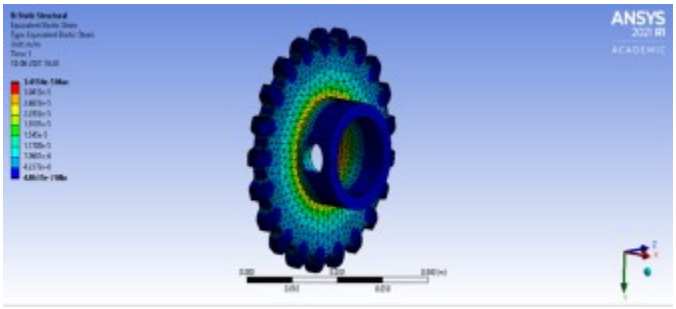


Fig6.6-Strain developed after Rotation of motor sprocket

VII. PROBLEM STATEMNTS

- 1 Problem: Device is not portable.
- 2 Problem: Use of water is high
- 3 Problem: Dishwasher leaves spots or a film on glassware.
- 4 Problem: Dishwasher running too long.

VIII. BENIFITS

- A dishwasher is highly efficient and eco-friendly. Research work on the appliance has shown that dishwasher uses only one third of the water that is used by hand washing. This is indeed an incredible piece of data for every household that uses so much of water and energy into washing the dishes is nothing but wastage of energy and resources. If using a dishwasher can save so much of water, then it is definitely the best method to adopt.
- Dishwasher also provides for the clearance of the kitchen clutter. Often the dishes remain strayed in the basin, making way for bad odour and even unhygienic consequences. However, with a dishwasher, all you have to do is stack those dishes away into the machine and relax while it politely handles the rest of your work.
- Dishwasher, no doubt gets your dishes much cleaner that the manual hand wash. With such advanced technology and engineering, dishwashers have been induced with the power to clean dishes without fail and give exceptional results to the users.
- Using a dishwasher is healthier and safer in many ways. For instance, washing a delicate teapot or glass tumbler that becomes soapy and slippery could result in broken glass all over your hands and the inside of your sink. Typically, dishes do not break inside the dishwasher.

IX. CONCLUSION

- This study seeks to improve environmental performance of typical household dishwashing.
- The Dishwasher's prime purpose is to wash the dishes and remove all kinds of unidentified particles hazardous to the health and to keep a proper Sanitization. The Dishwasher we have worked upon has all the basic fundamental components required to make the machine run and wash the dishes and plates.
- The Design calculation for Mechanism has been already been put to Calculations chapter where all the details regarding the numerical Mechanism aspects of dishwasher has been thoroughly mentioned. We have yet to test our Prototype version of Dishwasher as the situation is not stable right now, even though we have managed to complete the design and analysis section which will give you a brief preview about the outlook of

the Project. The Design and Fabrication of Dishwasher gives the certain idea regarding the Dishwasher as they have been constantly used in Household as well as commercial purpose too.

X. FUTURE SCOPE

- There are items that users are unwilling to load into the machine dishwasher. This may be because these items have soils that are more difficult to remove or they take up too much space in the machine. It remains unclear if these items are responsible for a higher fraction of manual dishwashing burdens.
- Experiments excluding the more heavily soiled items such as the baked spaghetti dish might result in less burdens from manual dishwashing.
- Future work might be possible in the Following ways: to reduce the weight of the machine. To improve the speed of the cleaning process by using alternative motor.
- To develop new ways to save water and energy.
- To use the leftover water from prior rinse cycles to pre-rinse the next one.

XI. REFERENCES

[1] Book of Theory of machines by R. S. Khurmi& J. K. Gupta

[2] Book of Design Data Book for Machine Element

[3] Design of Machine Element by B. D. Shivalkar

[4] Gaurav Gholap, Shankar Gaikwad, Sandesh Bhoite- "Design and Fabrication of Dish washing Machine" Department of Mechanical Engineering, Marathwada Mitra Mandal's Institute of Technology, Pune, India-47. Accepted 01 Oct 2016, Available online 05 Oct 2016, Special Issue-6 (pub Oct 2016), International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, PISSN 2347 – 5161

[5] YRD. DOÇ. DR. Y. Erhan Boke- "Thermal analysis and modelling of a dishwasher",Istanbul Technical University, Institute of Science and Technology

[6] Wisam Salih Muhsen, Muhammad Fahim Khadim- "Dishwasher-Related Injuries", published in 2014, Jan 30, International journal of injury control and safety promotion.

[7] Sofie Andersson and Johan Haggard- "Development of a Sustainable Dishwasher for Compact Living", Master of Science Thesis in the Master Degree Programs, Industrial Design Engineering and Product Development.

[8] Gabriela Yvonne Porras – "Life Cycle Comparison of Manual and Machine Dishwashing in Households", University of Michigan, April 2019.

[9] Alan Jeffe – "Engineering Analysis of A Domestic Dishwasher", 2020, February, 05.